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PROVISIONAL SPECIFICATION No. 2802, A.D. 1947.

Improvements in or relating to Constructional Materials

I, JAMES BENNIE, a British Subject, of 2, Tinworth Street, London, S.E.11, do hereby declare the nature of this invention to be as follows:—

5 This invention is for improvements in or relating to constructional materials.

It is an object of the present invention to provide a simple and efficient process for the manufacture of constructional 10 materials which are fireproof, light in weight and possess good thermal and sound insulating properties.

I have found that constructional materials, having these highly desirable 15 properties may be formed from a plastic mix having a basis of vermiculite which has been expanded or exfoliated into extremely light form by heating e.g. to a temperature of 900 to 1000° C. I have 20 further found that the properties of the mixture may be modified by the incorporation of a proportion of zinc oxide therein.

According to the present invention there 25 is provided a process for the production of a consolidated structural material having a basis of light weight porous mineral substance which process comprises mixing together expanded or exfoliated vermiculite or a mixture consisting largely of such vermiculite with a binder to form a plastic mix and rolling or otherwise moulding the mass into the structural material desired and thereafter heating to drive off moisture.

30 The binder may be sodium silicate and may be employed as 75° Twaddell sodium silicate or this may be diluted with water as desired.

Alternatively, the binder may consist of a resinous material, e.g. a synthetic resinous material. The resinous material

may consist for example of a coumarone resin.

The plastic mix may conveniently be 45 rolled between flexible sheets, e.g. between sheets of paper such as kraft paper or building paper to form a composite sheet or slab.

The mix may if desired include one or 50 more of the following materials: alumino silicate ($\text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \cdot 2\text{H}_2\text{O}$), sodium silico-fluoride, zinc or magnesium or calcium oxide, hydroxide or chloride, hydraulic cement, e.g. Portland cement, or plaster 55 of paris, chalk, limestone or clay.

In one form of the invention a mixture consisting of 90% by weight of exfoliated vermiculite and 10% by weight of zinc oxide is mixed with one third of its weight 60 of 70 Twaddell sodium silicate (to which a proportion of water has been added if necessary to facilitate working into a kneadable mass). The plastic mix may be rolled between sheets of paper and the 65 sheet-like article may then be dried by heating e.g. to a temperature between 250 and 300° C. between perforated metal plates. Under these conditions drying takes place within one to two hours.

70 There may be incorporated in the mix a proportion of one or more other mineral materials, preferably fibrous mineral materials and among such substances may be mentioned asbestos.

The products are chemically inert, rot proof and vermin proof. When they are to be used out of doors a liquid water-repellent material may be incorporated therein.

Dated this 29th day of January, 1947.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.1,
Chartered Patent Agents,

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PROVISIONAL SPECIFICATION No. 28054, A.D. 1947

Improvements in or relating to Constructional Materials

I, JAMES BENNIE, of 2, Tinworth Street, London, S.E.11, a British Subject, do hereby declare the nature of this invention to be as follows:—

This invention is for improvements in 85 or relating to constructional materials

and has particular though not exclusive reference to compound sheet material for constructional purposes.

In Specification No. 2802/47 I have disclosed a process for the production of a consolidated structural material having a basis of light weight porous mineral substance which process comprises mixing together expanded or exfoliated vermiculite or a mixture consisting largely of such vermiculite with a binder to form a plastic mix and rolling or otherwise moulding the mass into the structural material desired and thereafter heating to drive off moisture. The binder may be sodium silicate and may be employed as 75° Twaddell sodium silicate or this may be diluted with water as desired.

The plastic mix may be rolled between flexible sheets, e.g. between sheets of paper such as kraft paper or building paper to form a composite sheet or slab.

It is an object of the present invention to provide a process for the manufacture of modified forms of boards or other building elements which elements are strong, light and durable.

According to the present invention there is provided a process for the production of a multi-ply building element, e.g. a multi-ply sheet building element, which process comprises mixing together expanded or exfoliated vermiculite or a mixture containing a predominating proportion of such material and a binder to form a plastic mix, forming the said mix into a sheet material between facing sheets and assembling two or more of the compound sheets thus formed with adhesive 40 to form a consolidated product.

The individual facing sheets of which the consolidated product is built up may consist of fibrous material mixed with sodium silicate to form a plastic mix and 45 rolled between sheets of paper. Boards such as are prepared in accordance with the invention may be used as facing sheets for substantially thicker elements.

When the final product is to be rendered waterproof it should be dipped into a hot bath consisting of, e.g. a 10% solution of glue, removed, allowed to drain and then dipped into a solution containing 10% of 50 40% formaldehyde. The unit is finally 55 dried. Another suitable fireproofing solution consists of:—

100 parts by vol. of an aqueous solution of silicate of soda, specific gravity 1.4; 60 12 parts by vol. of an aqueous solution of sodium bicarbonate, saturated at 60° F. 20° Beaumé; 6 parts by vol. of an aqueous solution of borax, saturated at 60° F. 20° Beaumé.

These ingredients are thoroughly mixed 65 with an equal part by weight of commer-

cial zinc dust and the mixture then immediately brushed on, or the board may be bathed in this solution.

The coated board should be allowed to stand in a normal temperature for a period of 6 to 8 hours after which it is subjected to heat treatment in an oven at a temperature which may vary from 450° F. to 700° F. for a period of from 2 to 4 hours. Alternatively a solution of synthetic resin with or without filler or pigment may be sprayed or painted upon the unit.

The binder for the vermiculite mixture may consist of an alkali silicate for example sodium silicate or alternatively of a urea formaldehyde syrup which is preferably mixed with sulphonated castor oil and with a sulphuric acid catalyst.

The individual components may conveniently be united to form the consolidated unit by means of an adhesive consisting of 75° Twaddell sodium silicate with the application of pressure for example in a hot press. Pressure for twelve hours under a pressure of 20 lbs. per square foot has been found to be satisfactory.

Other adhesives such as calcium caseinate or bitumen may be used instead of sodium silicate and when a waterproof product is required a synthetic resin may be used with advantage.

In order to increase the strength of the product, the individual plies may be treated with glue and formaldehyde as indicated above. Further the sheets may be reinforced with e.g. wire-netting expanded metal or rods, suitably of from $\frac{1}{8}$ " to $\frac{1}{2}$ " diameter.

The strength of the product may also be increased by incorporating fibrous material e.g. sawdust, peat, straw and reeds with the vermiculite. Thus, for example, 50% of vermiculite (No. 2 grade) may be mixed with 50% of a mixture of two parts of flax shives, one part of asbestos, one part of zinc oxide and a half part of sodium silico fluoride, the whole being incorporated with sodium silicate to form a plastic mix. Alternatively, 33 $\frac{1}{3}$ % of the vermiculite may be mixed with 33 $\frac{1}{3}$ % of cork and 33 $\frac{1}{3}$ % of a mixture consisting of two parts of sawdust or flax shives, one part of asbestos, one part of zinc oxide and a half part of sodium silico fluoride the mixture then being incorporated with sodium silicate to form a mouldable mass.

Another composition which may be used with advantage in carrying out the present invention consists of four parts by weight of silicate of soda (75° Twaddell), one part by weight of zinc oxide and vermiculite sufficient in amount to form a plastic mix.

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Alternatively, 32 parts of silicate of soda (75° Twaddell), 21 parts of zinc oxide, 4 parts of magnesium oxide and 3 parts of red lead may be mixed to form a paste, 5 an equal weight of 75° Twaddell sodium silicate added and vermiculite sufficient to form a plastic mix.

Instead of being rolled between sheets of paper, e.g. building paper, the plastic mix 10 may be rolled between sheets of aluminium, zinc or steel or between sheets consisting of different materials.

In a modification of the process the plastic mix may be pressed into a card-board 15 or sheet metal tray, e.g. of aluminium, the external dimensions of which correspond to the finished dimen-

sions of the building element, a lid fitted and secured and the mixture dried to form the final cased product.

Building units made in accordance with the present invention may vary in thickness e.g. from $\frac{1}{8}$ inch up to 5 inches in thickness and from one foot square to some 8 ft. by 4 ft. In addition building 25 elements such as beams, joists and slats may be made in accordance with the invention.

Dated this 20th day of October, 1947.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.1,
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in or relating to Constructional Materials

I, JAMES BENNIE, a British Subject, of 30 2, Tinworth Street, London, S.E.11, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following 35 statement:—

This invention is for improvements in or relating to constructional materials and has reference to compound sheet material for constructional purposes.

It is an object of the present invention 40 to provide a simple and efficient process for the manufacture of constructional materials which are fireproof, light in weight and possess good thermal and sound insulating properties.

I have found that constructional materials, having these highly desirable properties may be formed from compound sheet prepared using a plastic mix having 50 a basis of vermiculite which has been expanded or exfoliated into extremely light form by heating, e.g. to a temperature of 900 to 1000° C. I have further found that the properties of the mixture 55 may be modified by the incorporation of proportions of other materials, e.g. zinc oxide, therein.

According to the present invention there is provided a process for the production 60 of a consolidated structural material, which process comprises mixing together expanded or exfoliated vermiculite, or a mixture containing such vermiculite, with a binder to form a plastic mix, forming 65 the said mix into a sheet between facing sheets to produce a composite sheet or slab and thereafter heating to drive off moisture.

The binder may be sodium silicate 70 solution and may be employed as 75° Twaddel sodium silicate (in which the

ratio $\text{Na}_2\text{O}:\text{SiO}_2$ is between 1:3 and 1:3.30) or this may be diluted with water as desired.

Alternatively, the binder may consist 75 of a resinous material, e.g. a synthetic resinous material. The resinous material may consist for example of a coumarone resin or of a urea formaldehyde syrup which is preferably mixed with sulphonated castor oil and with a sulphonic acid catalyst. Other binders such as calcium caseinate or bitumen may be used instead of sodium silicate.

The plastic mix may conveniently be 85 rolled between sheets of paper such as kraft paper or building paper or asbestos paper to form the composite sheet or slab. Alternatively, it may be rolled between plywood sheets, veneered or unveneered.

The mix may if desired include one or more of the following materials: aluminium silicate ($\text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \cdot 2\text{H}_2\text{O}$), sodium silicofluoride, zinc or magnesium or calcium oxide, hydroxide or chloride, 95 hydraulic cement, e.g. Portland cement, or plaster of paris, chalk, limestone or clay.

In one form of the invention a mixture consisting of 90% by weight of exfoliated vermiculite and 10% by weight of zinc oxide is mixed with one third of its weight of 100 70° Twaddell sodium silicate (to which a proportion of water has been added if necessary to facilitate working into a kneadable mass). The plastic mix may be rolled between sheets of paper and the sheet-like article may then be dried by heating e.g. to a temperature between 250 and 300° C. between perforated metal 105 plates. Under these conditions drying takes place within one to two hours.

Further, according to the present invention there is provided a process for the

production of a multi-ply building element, e.g. a multi-ply sheet building element, which process comprises mixing together expanded or exfoliated vermiculite or a mixture containing such vermiculite and a binder to form a plastic mix, forming the said mix into a sheet material between facing sheets, heating to drive off moisture, and assembling two or more of

- 5 the compound sheets thus formed with adhesive to form a consolidated product.
- Two or more composite sheets or slabs prepared as described above may be united by adhesive e.g. by synthetic resin
- 10 or by silicate of soda to form a consolidated product.

The individual facing sheets of which the consolidated product is built up may consist of fibrous material mixed with 20 sodium silicate to form a plastic mix and rolled between sheets of paper. Boards such as are prepared in accordance with the invention may be used as facing sheets for substantially thicker elements.

- 25 When the final product is to be rendered waterproof it should be dipped into a hot bath consisting of, e.g. a 10% solution of glue, removed, allowed to drain and then dipped into a solution containing 10% of 40% formaldehyde. The unit is finally dried. A suitable fireproofing solution consists of:—

100 parts by vol. of an aqueous solution of silicate of soda, specific gravity 1.4; 35 12 parts by vol. of an aqueous solution of sodium bicarbonate, saturated at 60° F. 20° Beaumé; 6 parts by vol. of an aqueous solution of borax, saturated at 60° F. 20° Beaumé.

- 40 These ingredients are thoroughly mixed with an equal part by weight of commercial zinc dust and the mixture then immediately brushed on, or the board may be bathed in this mixture.

45 The coated board should be allowed to stand at air temperature for a period of 6 to 8 hours after which it is subjected to heat treatment in an oven at a temperature which may vary from 230° C. to 50 370° C. for a period of from 2 to 4 hours.

Alternatively a solution of synthetic resin with or without filler or pigment may be sprayed or painted upon the unit.

The individual components may conveniently be united to form the consolidated unit by means of an adhesive consisting of 75° Twaddell sodium silicate in which the ratio Na₂O : SiO₂ is between 1:3 and 1:3.30 with the application of 60 pressure for example in a hot press. Pressure for twelve hours under a pressure of 20 lbs. per square foot has been found to be satisfactory.

In order to increase the strength of the 65 product, the individual plies may be

treated with glue and formaldehyde as indicated above. Further the sheets may be reinforced with e.g. wire-netting, expanded metal or rods, suitably of from $\frac{1}{8}$ " to $\frac{1}{2}$ " diameter.

70 The strength of the product may also be increased by incorporating fibrous material e.g. sawdust (which may be treated with sodium silicate), peat, straw, reeds, flax shives, coffee grounds or asbestos with the vermiculite in the proportion of from 25% to 50% or even greater by weight on the total weight of the vermiculite. Thus, for example, 50% of vermiculite (No. 2 grade) may be mixed 75 with 50% of a mixture of two parts of flax shives, one part of asbestos, one part of zinc oxide, and a half part of sodium silico fluoride, the whole being incorporated with sodium silicate to form a plastic mix. 80 Alternatively, 33 $\frac{1}{3}$ % of the vermiculite may be mixed with 33 $\frac{1}{3}$ % of cork and 33 $\frac{1}{3}$ % of a mixture consisting of two parts of sawdust or flax shives, one part of asbestos, one part of zinc oxide and a half 85 part of sodium silico fluoride the mixture then being incorporated with sodium silicate to form a mouldable mass.

Another composition which may be used with advantage in carrying out the 90 present invention consists of four parts by weight of silicate of soda (75° Twaddell), one part by weight of zinc oxide and vermiculite sufficient in amount to form a plastic mix.

95 Alternatively, 32 parts by weight of silicate of soda (75° Twaddell), 21 parts by weight of zinc oxide, 4 parts by weight of magnesium oxide and 3 parts by weight of red lead may be mixed to form a paste, 100 an equal weight of 75° Twaddell sodium silicate added and vermiculite sufficient to form a plastic mix.

Further plastic mixes may consist of

(a) 3 parts by weight of No. 5, 3 or 2 110 vermiculite;

1 part by weight of asbestos;

$\frac{1}{2}$ part by weight of zinc oxide;

$\frac{1}{4}$ part by weight of sodium silico fluoride;

$\frac{1}{4}$ part by weight of ordinary quick-setting cement; or

(b) $\frac{1}{2}$ parts by weight of No. 5, 3 or 2 vermiculite;

$\frac{1}{2}$ parts by weight of treated sawdust, 120 flax shives, cork, coffee grounds or peat;

1 part by weight of asbestos;

$\frac{1}{2}$ part by weight of zinc oxide;

$\frac{1}{4}$ part by weight of sodium silico fluoride;

$\frac{1}{4}$ part by weight of ordinary quick-setting cement.

125 In each case the mix has incorporated with it sufficient sodium silicate, 75° Twaddell, to form a plastic mass which is 130

then rolled between sheets e.g. of paper.

Instead of being rolled between sheets of paper, e.g. building paper, the plastic mix may be rolled between sheets of 5 aluminium, zinc or steel or between sheets consisting of different materials.

In a modification of the process the plastic mix may be pressed into a card-board or sheet metal tray, e.g. of 10 aluminium, the external dimensions of which correspond to the finished dimensions of the building element, a lid fitted and secured and the mixture dried to form the final cased product.

15 Building units made in accordance with the present invention may vary in thickness e.g. from $\frac{1}{8}$ inch up to 5 inches in thickness and from one foot square to some 8 ft. by 4 ft. In addition building 20 elements such as beams, joists and slats may be made in accordance with the invention.

The products are chemically inert, rot proof and vermin proof. When they are 25 to be used out of doors a liquid water-repellent material may be incorporated therein.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for the production of a consolidated structural material which 35 process comprises mixing together expanded or exfoliated vermiculite, or a mixture containing such vermiculite, with a binder to form a plastic mix, forming the said mix into a sheet between facing 40 sheets to produce a composite sheet or slab and thereafter heating to drive off moisture.

2. A process as claimed in claim 1 wherein the binder consists of sodium 45 silicate solution ($\text{Na}_2\text{O} : \text{SiO}_2$ between 1:3 and 1:3.30).

3. A process as claimed in claim 2 wherein the sodium silicate solution is a 75° Twaddell sodium silicate.

40 4. A process as claimed in claim 1 wherein the binder consists of a resinous material e.g. a synthetic resinous material.

5. A process as claimed in claim 4 wherein the binder consists of a coumarone 45 resin or of a urea formaldehyde resin.

6. A process as claimed in any one of

the preceding claims wherein the plastic mix is rolled between sheets of paper.

7. A process as claimed in any one of the 60 preceding claims wherein the plastic mix is rolled between sheets of metal.

8. A process as claimed in any one of the preceding claims wherein the metal sheets consist of aluminium, zinc or steel. 65

9. A process for the production of a consolidated structural material as claimed in any one of the preceding claims wherein two or more of the composite sheets or slabs are united by adhesive to form a 70 consolidated product.

10. A process as claimed in claim 9 wherein the individual facing sheets of which the consolidated product is built up are formed by mixing fibrous material 75 with sodium silicate to form a plastic mass and rolling the mass between sheets of paper.

11. A process as claimed in any one of the preceding claims wherein the product 80 is waterproofed by dipping into a hot solution of glue and thereafter into a solution of formaldehyde.

12. A process as claimed in any one of the preceding claims wherein the product 85 is fireproofed by treatment with an aqueous mixture of silicate of soda, sodium bicarbonate, borax and zinc dust.

13. A process as claimed in any one of the preceding claims wherein the structural 90 material is reinforced by means of wire-netting, expanded metal or rods.

14. A process as claimed in any one of the preceding claims wherein fibrous material is incorporated in the plastic mix 95 together with the vermiculite.

15. A process as claimed in claim 14 wherein the fibrous material comprises sawdust, peat, straw, reeds, flax shives or asbestos. 100

16. A process as claimed in any one of the preceding claim wherein a proportion of zinc oxide is incorporated in the vermiculite mix.

17. A process for the production of a 105 consolidated structural material substantially as described.

18. A consolidated structural material when made by the process claimed in any one of the preceding claims. 110

Dated this 29th day of January, 1948.
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111 & 112, Hatton Garden, London, E.C.1,
Chartered Patent Agents,

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